



WIND MICROCLIMATE ASSESSMENT REPORT

Port Street, Manchester

5 July 2023

GIA No: 1620

PROJECT DATA:

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1 INTRODUCTION

This report outlines the results of a wind microclimate analysis for the proposed development at Port Street, Manchester.

1.1 EXECUTIVE SUMMARY

Wind microclimate conditions for the proposed development at Port Street, Manchester were assessed using high resolution Computational Fluid Dynamics (CFD), in relation to Condition 42 of the planning consent for application ref. 132489/FO/2021

The model was updated to incorporate the stage 3 massing and landscaping scheme, and an 1800mm glazed balustrade (dropping to 1500mm at the eastern end) was added to the level 7 terrace.

Conditions were suitable for the intended use, and not subject to any significant wind safety risks, for the ground floor public realm.

Conditions were suitable for the intended use, and not subject to any significant wind safety risks, for the level 7 terrace.

1.2 BACKGROUND

This report is provided in accordance with Condition 42 of the planning consent for application ref. 132489/FO/2021 Condition 42 states:

“Before development commences final details of the wind mitigation to the level 7 terraces and public realm shown in dwgs 10376-SHP-Z0-A-B5D8-G200-PL-07-001 Rev PO2 and Landscape Strategy 0894-RFM-XX-ZZ-RP-L-0001-S2 P04 and confirmation from a suitably qualified Wind Consultant that this would be adequate shall be submitted to and approved in writing. The approved scheme shall be implemented prior to any use of the terrace and public realm commencing and thereafter retained and maintained in situ.”

As such, this wind assessment is focused on the conditions for the ground floor public realm and the level 7 terrace, when tested with the updated design of the proposed development and including the updated landscaping scheme.

2 METHOD

To identify the likely effect of the proposed development on the pedestrian level wind environment, a 3D CFD model of the development and surrounding site was created. This section describes the methodology for the creation of this model and the inputs used.

2.1 ASSESSMENT METHODOLOGY

The assessment was performed using GIA's high-resolution Computational Fluid Dynamics (CFD) modelling.

CFD is a digital modelling technique, which simulates the effect of wind for the built environment. The air is divided into hundreds of millions of "cells", within which the equations of motion are solved. GIA uses cloud computing from Amazon Web Services (AWS) to run the simulations, to ensure vast scalability and appropriate resource availability for any project.

A full description of the test methodology is included in Appendix 01.

2.2 ESTABLISHING MICROCLIMATE CONDITIONS

Microclimate conditions were established using a high resolution CFD model, extending 400m radius from the Site.

A model of the development was included within the CFD model and tested to determine the conditions at and around the Site. The model used is shown in Figure 1 and Figure 2.

The model was run at full scale from 18 wind angles, spaced using 10° or 30° increments such that no sector contributes more than 10% of the annual wind. The wind angles which were run are indicated in Appendix 01.

Wind speeds were measured at 1.5m above any surfaces expected to be used for pedestrian activity.

On-site and local wind speeds were combined with wind statistics from 30 years of data recorded at Manchester International Airport for variations in terrain between the airport and the site, to obtain annual and seasonal frequency and magnitude of wind speeds across the model. This allows the 'grading' of the pedestrian level winds according to the Lawson Comfort Criteria, which are explained later in this report.

The mean correction factors between the site and the airport are shown in Table 1.

The wind microclimate effects are assessed annually, for the winter months (December, January and February) and for the summer months (June, July, August). Winter conditions are reported as this is the season when the strongest winds are expected, summer conditions are reported as this is the season when pedestrian usage of outdoor spaces is expected to be highest.

2.3 LIMITATIONS AND ASSUMPTIONS

The accuracy of the results is dependent upon the accuracy of the CAD used to construct the model.

There is an inherent assumption that on-site wind speeds will scale linearly with the measured wind speeds at the airport.

There is an inherent assumption that the wind speed statistics for the past 30 years will remain applicable for the foreseeable future.

Table 01: Site Wind Correction Factors

DIRECTION (°N)	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
Corr. Factor	1.56	1.48	1.48	1.47	1.38	1.31	1.31	1.30	1.31	1.30	1.43	1.41



Fig. 01: 3D View of proposed Development

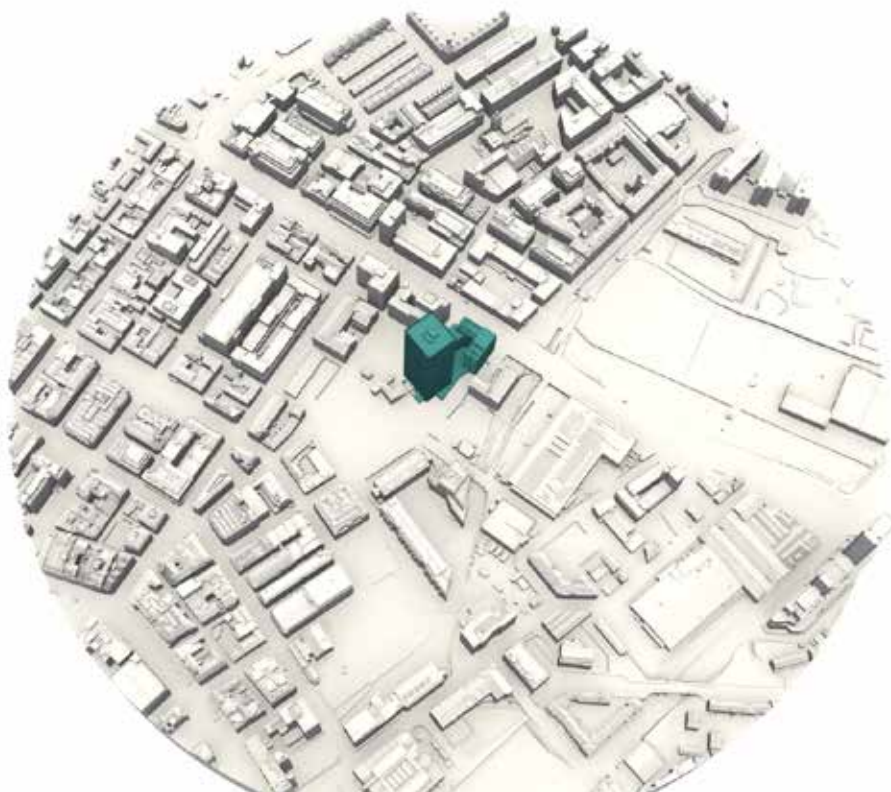


Fig. 02: Proposed Development with Existing Surrounds

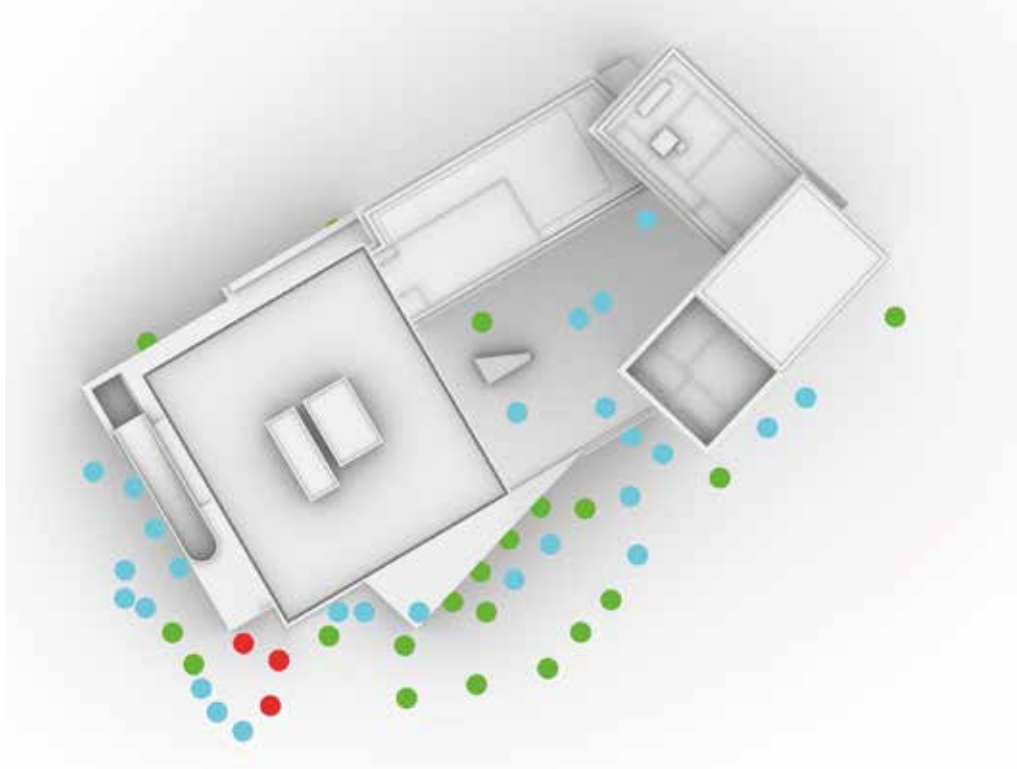


Fig. 03: Ground Floor Tree Planting Strategy (blue – small deciduous, green – medium deciduous, red – medium evergreen)

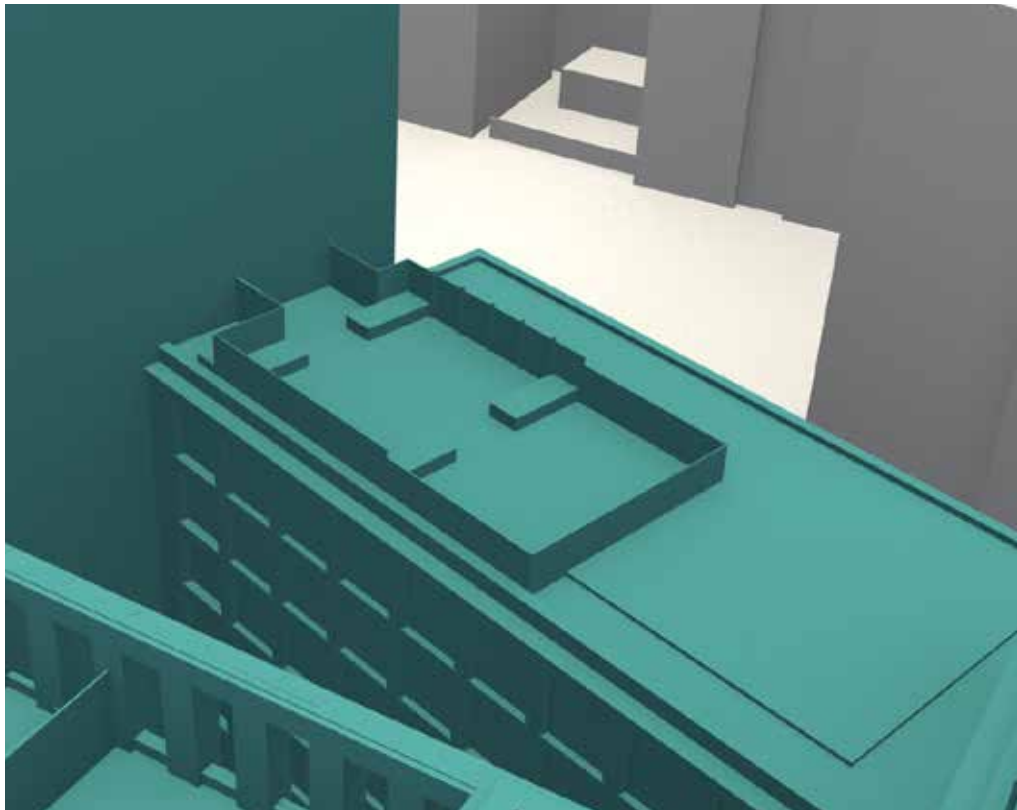


Fig. 04: The Proposed Level 7 Terrace

2.4 LAWSON COMFORT AND SAFETY CRITERIA

The assessment was graded against the Lawson Comfort and Safety Criteria.

Table 2 and Table 3 show the banding of the various categories within the Lawson Comfort and Safety criteria.

Comfort categories are based on the level of wind speed exceedance for 5% of each season, and safety categories are based on the level of wind speed exceedance for ~2 hours per year.

The assessment was performed using the London Docklands Development Corporation (LDDC) variant of the Lawson Comfort Criteria. The Lawson Criteria are well-established in the UK for quantifying wind conditions in relation to build developments and, although not a UK 'standard', the criteria are recognised by local authorities as a suitable benchmark for wind assessments. The Lawson Criteria have been adopted for this assessment.

Table 02: Lawson Comfort Criteria (LDDC variant)

KEY	COMFORT CATEGORY	MEAN WIND SPEED (5% EXCEEDANCE)	DESCRIPTION
	Sitting	4 m/s	Acceptable for outdoor sitting use (e.g. cafés, benches, balconies and terraces)
	Standing	6 m/s	Acceptable for main building entrances, pick-up / drop-off points and bus stops
	Walking (leisure)	8 m/s	Acceptable for strolling
	Walking (business)	10 m/s	Acceptable for external pavements, walking purposefully without lingering
	Uncomfortable	>10 m/s	Not comfortable for regular pedestrian access

Table 03: Lawson Safety Criteria (LDDC variant)

KEY	SAFETY CATEGORY	MEAN WIND SPEED (0.025% EXCEEDANCE)	DESCRIPTION
	No Safety Exceedance	<15 m/s	
	S15 (Distress)	>15 m/s	Unsafe for frail individuals, or cyclists
	S20 (Safety)	>20m/s	Wind conditions considered unsafe for all users

2.5 TARGET CONDITIONS

Any areas which show up as either unsafe (annually) or uncomfortable (for winter) will require mitigation, unless they are in locations where pedestrian access can be controlled in the event of strong winds.

The target conditions for the proposed public realm and level 7 terrace are both based upon summer conditions, as this is the season for which the use of outdoor amenity space is not limited by factors such as temperature or rainfall.

Both the public realm and the level 7 terrace are targeted to be suitable for a mixture of sitting and standing in summer. This will ensure that there is always a suitable space for any user dependent on their desired level of physical activity.

2.6 KEY MODEL UPDATES

An updated model of the proposed development has been included in the assessment, to reflect the stage 3 design of the proposed development.

Proposed landscaping has been included in accordance with the updated landscaping scheme. This includes both the fence along the perimeter of the raised platform, and tree planting in accordance with the locations shown in Figure 3.

Three types of tree were included in the model:

- Small deciduous (2.5-3m tall, shown in blue in Figure 3);
- Medium deciduous (5-6m tall, shown in green in Figure 3); and
- Medium evergreen (5-6m tall, shown in red in Figure 3).

A 1800mm glazed balustrade has been included around the perimeter of the level 7 terrace, which drops to 1500mm for the region at the eastern end (shown in Figure 4).

2.7 TEST SCENARIOS

The purpose of these tests was to assess conditions for the public realm and level 7 terrace of the proposed development.

The following scenario was tested:

- Proposed Development, Existing Surrounds: The completed and operational development with the existing surrounds.

The wind microclimate assessment which was submitted with application 132489/FO/2021 showed that the inclusion of future committed schemes (as a cumulative assessment) would result in similar, but marginally calmer, wind conditions.

As such, if conditions are suitable for the scenario with existing surrounds then they will also remain suitable once the cumulative schemes from the original wind assessment come forwards.

3 RESULTS

3.1 GROUND LEVEL PUBLIC REALM CONDITIONS

Annual safety at ground level for the proposed development with existing surrounds is shown in Figure 5. Winter comfort at ground level for the proposed development with existing surrounds is shown in Figure 6. Summer comfort at ground level for the proposed development with existing surrounds is shown in Figure 7.

There are no significant regions of safety exceedance at ground level.

Winter conditions for the public realm are suitable for a mixture of sitting, standing and leisure walking.

Summer conditions for the public realm are suitable for a mixture of sitting and standing.

This is suitable for the intended use.

3.2 LEVEL 7 TERRACE CONDITIONS

Annual safety at level 7 for the proposed development with existing surrounds is shown in Figure 8. Winter comfort at level 7 for the proposed development with existing surrounds is shown in Figure 9. Summer comfort at level 7 for the proposed development with existing surrounds is shown in Figure 10.

There are no safety exceedances on the level 7 terrace.

For both winter and summer, conditions for the terrace are suitable for a mixture of sitting and standing.

For summer, the majority of the terrace is suitable for sitting.

This is suitable for the intended use.

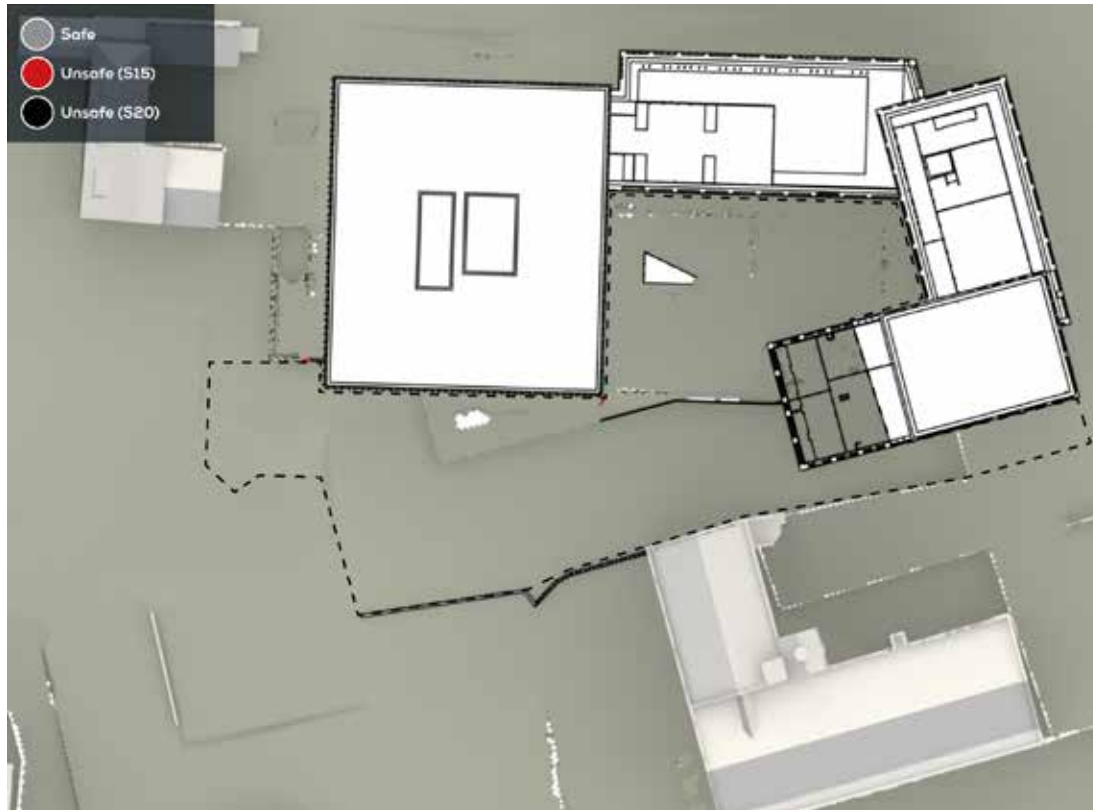


Fig. 05: Annual Safety at Ground Level, Proposed Development with Existing Surrounds

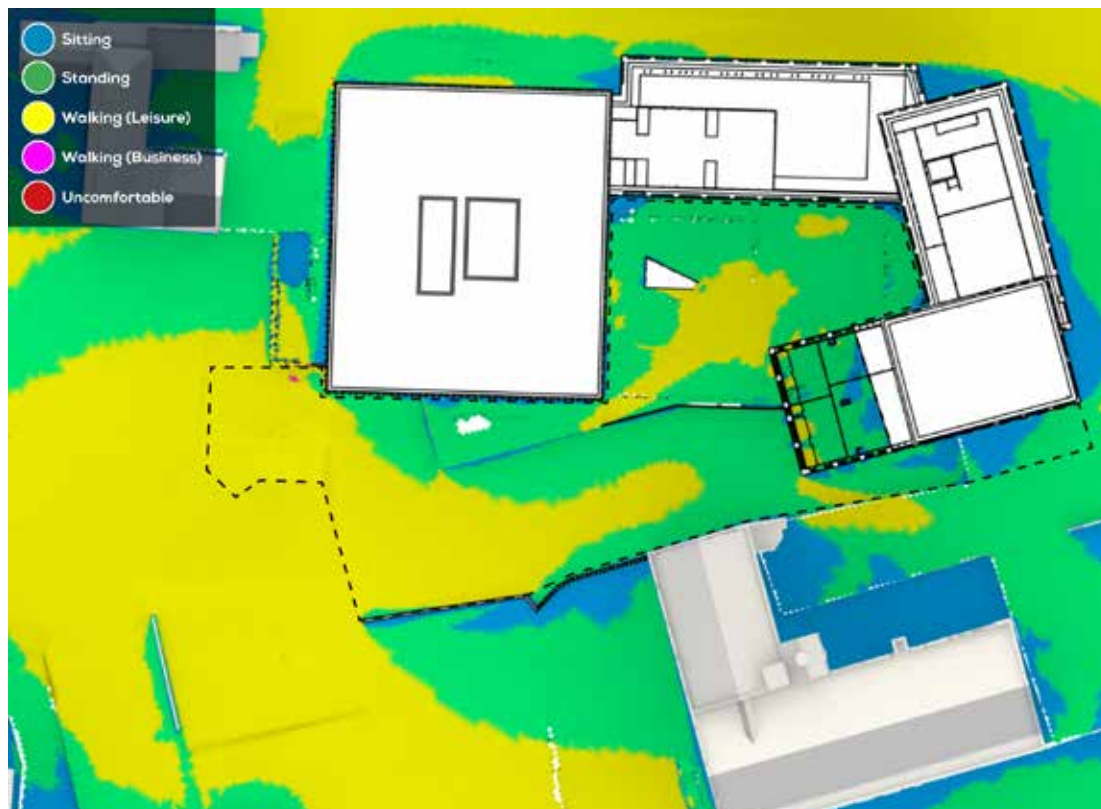


Fig. 06: Winter Comfort at Ground Level, Proposed Development with Existing Surrounds

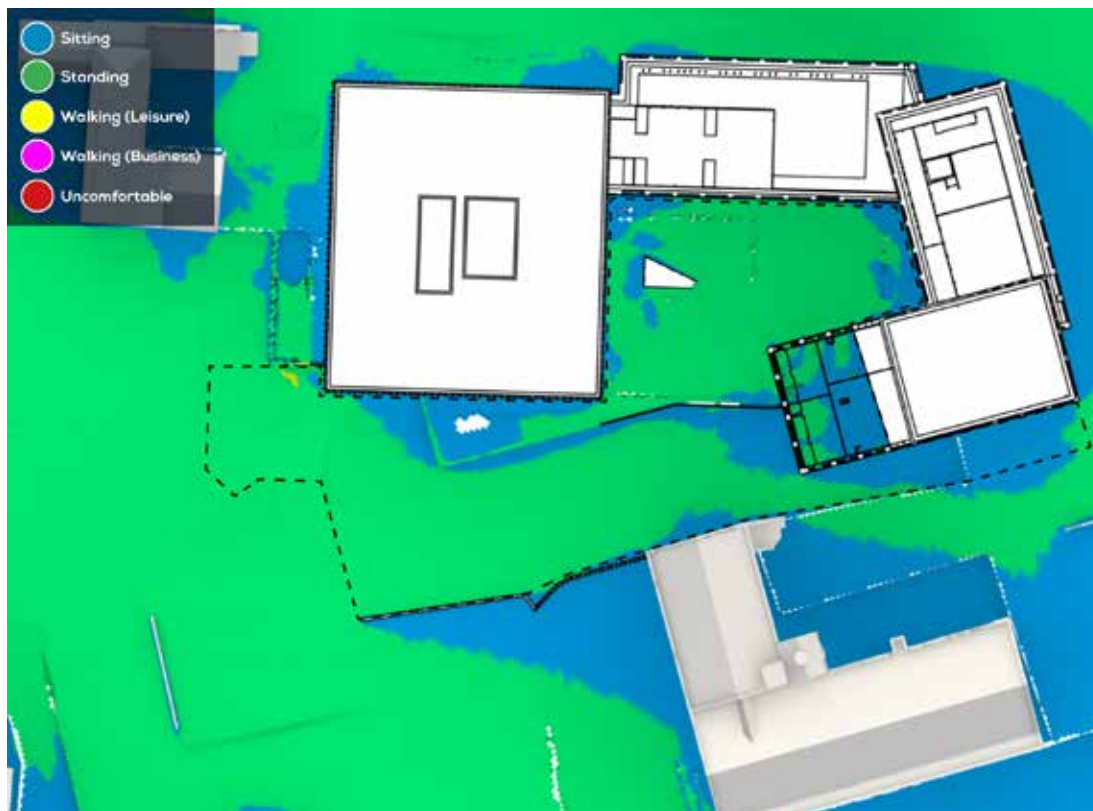


Fig. 07: Summer Comfort at Ground Level, Proposed Development with Existing Surrounds



Fig. 08: Annual Safety at Level 7, Proposed Development with Existing Surrounds

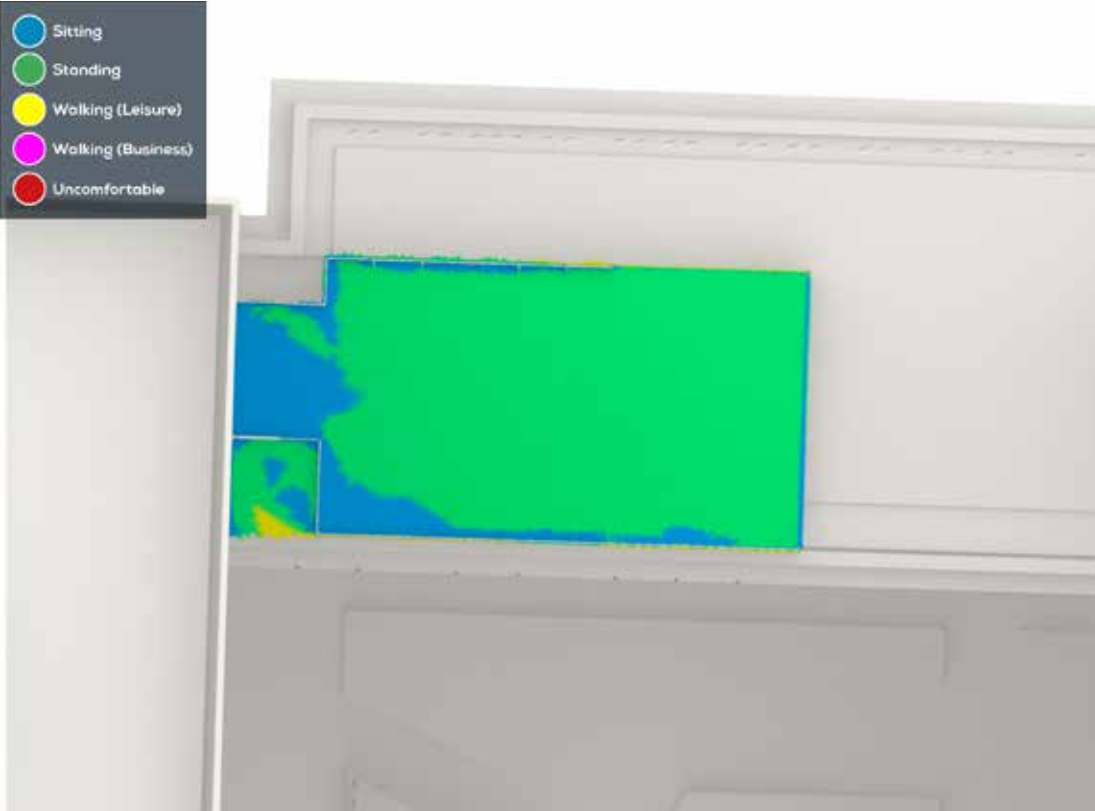


Fig. 09: Winter Comfort at Level 7, Proposed Development with Existing Surrounds

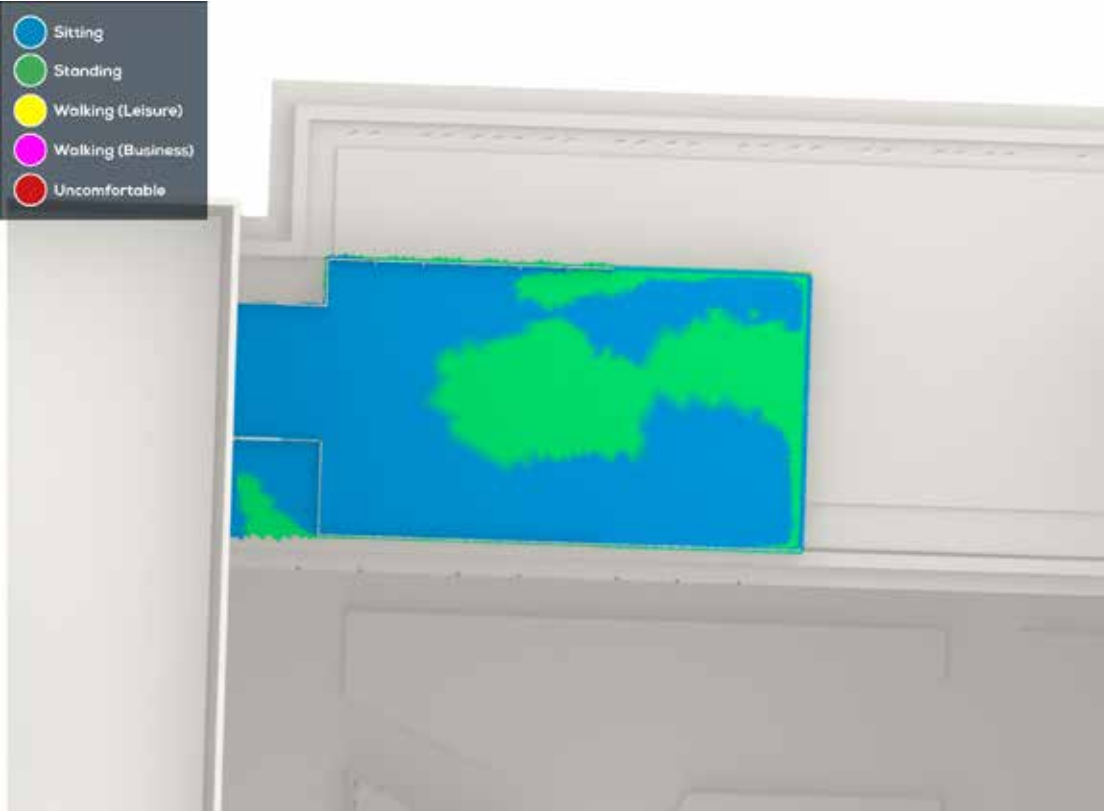


Fig. 10: Summer Comfort at Level 7, Proposed Development with Existing Surrounds

4 CONCLUSIONS

Wind microclimate conditions for the proposed development at Port Street, Manchester were assessed using high resolution Computational Fluid Dynamics (CFD), in relation to Condition 42 of the planning consent for application ref. 132489/FO/2021

The model was updated to incorporate the stage 3 massing and landscaping scheme, and an 1800mm glazed balustrade (dropping to 1500mm at the eastern end) was added to the level 7 terrace.

Conditions were suitable for the intended use, and not subject to any significant wind safety risks, for the ground floor public realm.

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APPENDIX 01 DETAILED METHODOLOGY

CFD METHODOLOGY

The CFD was performed using OpenFOAM.

Meshed using a hybrid mesh of hexahedral, polyhedral, tetrahedral and prismatic elements:

- On site building edge length: 0.05m – 0.25m
- Surrounding context edge length: 0.25m – 1m

Prismatic cells were used in the boundary layer region, with 4 layers of cells growing with an expansion ratio of 1.15 and aspect ratios between 0.1 and 0.4.

The total mesh size was 138 million cells. Mesh detail is shown in Figure 11 and Figure 12.

Buildings within 400m of the site were included.

The domain was 5000mx5000m, with a blockage ratio of 0.5%

The blockage ratio uses a “test section” of 600mx200m (within which detail is captured).

Run using the SST turbulence model with high Re wall functions to ensure mesh suitability.

The simulations were steady state and isothermal.

2nd order discretisation schemes were used.

Convergence was measured as the residuals of the continuity, x-velocity, y-velocity, z-velocity, k and omega equations all falling by at least 2 orders of magnitude, and by measured static pressure on the site buildings varying by less than 1% over the final 100 iterations.

The wind speed is corrected into a “gust-equivalent” mean. The gust-equivalent mean is calculated using an empirical relationship between the gust and mean ratios recorded at over 13,000 data points from wind tunnel tests. This method is found to give a significant correlation improvement over the more traditional methods based on the CFD turbulent kinetic energy field.

WIND CLIMATE METHODOLOGY

The simulations were performed from 18 wind directions, spaced such that no single direction contributed more than 10% of the annual winds.

The directions simulated were 0°, 30°, 60°, 90°, 120°, 150°, 170°, 180°, 190°, 200°, 210°, 220°, 240°, 260°, 270°, 280°, 300°, 330°.

Seasonal wind roses for Manchester International Airport are shown in Figure 13.

Target wind profiles for the site, from each wind direction, were generated using sectoral analysis of the terrain surrounding the site and the local weather stations with ESDU 2010 Item 01008 ‘Computer program for wind speeds and turbulent properties: flat or hilly sites in terrain with roughness changes’. The target wind profiles, compared to the wind speeds measured from the CFD model are shown in Figure 14.

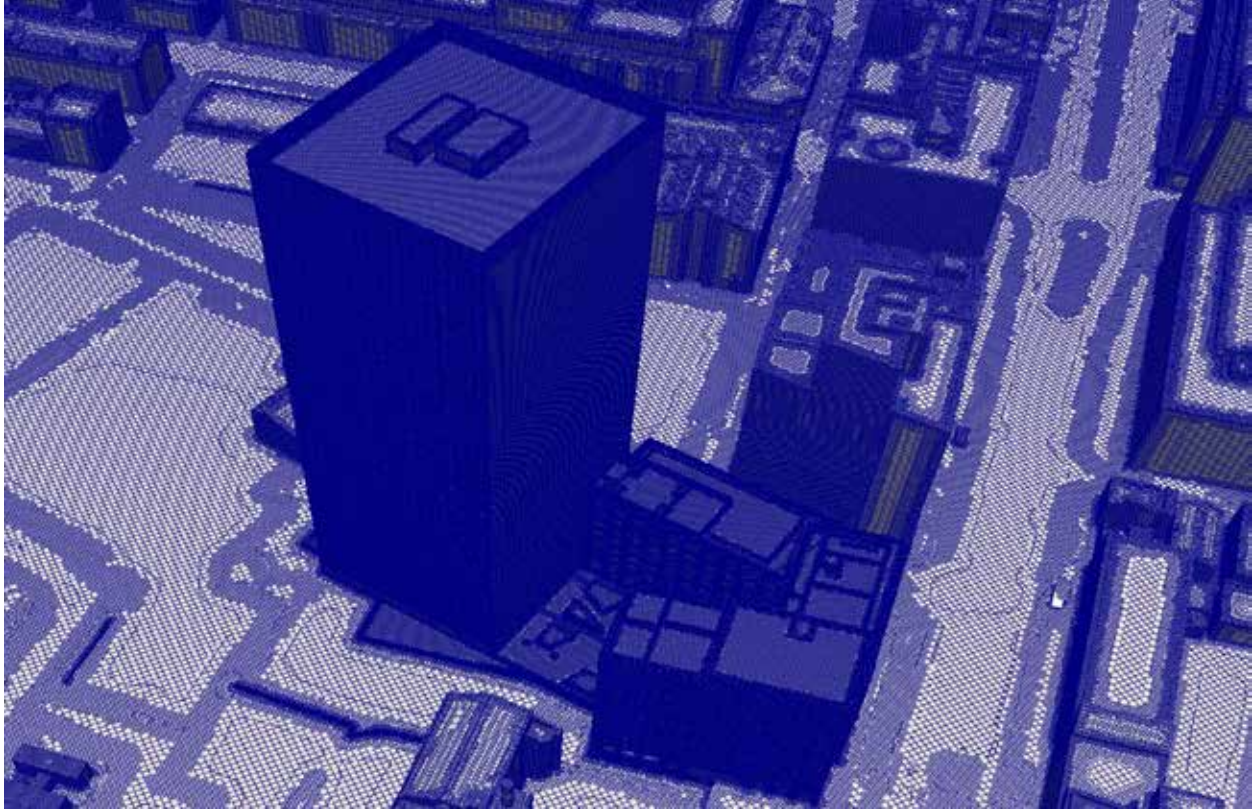


Fig. 11: Mesh Detail on Site Buildings

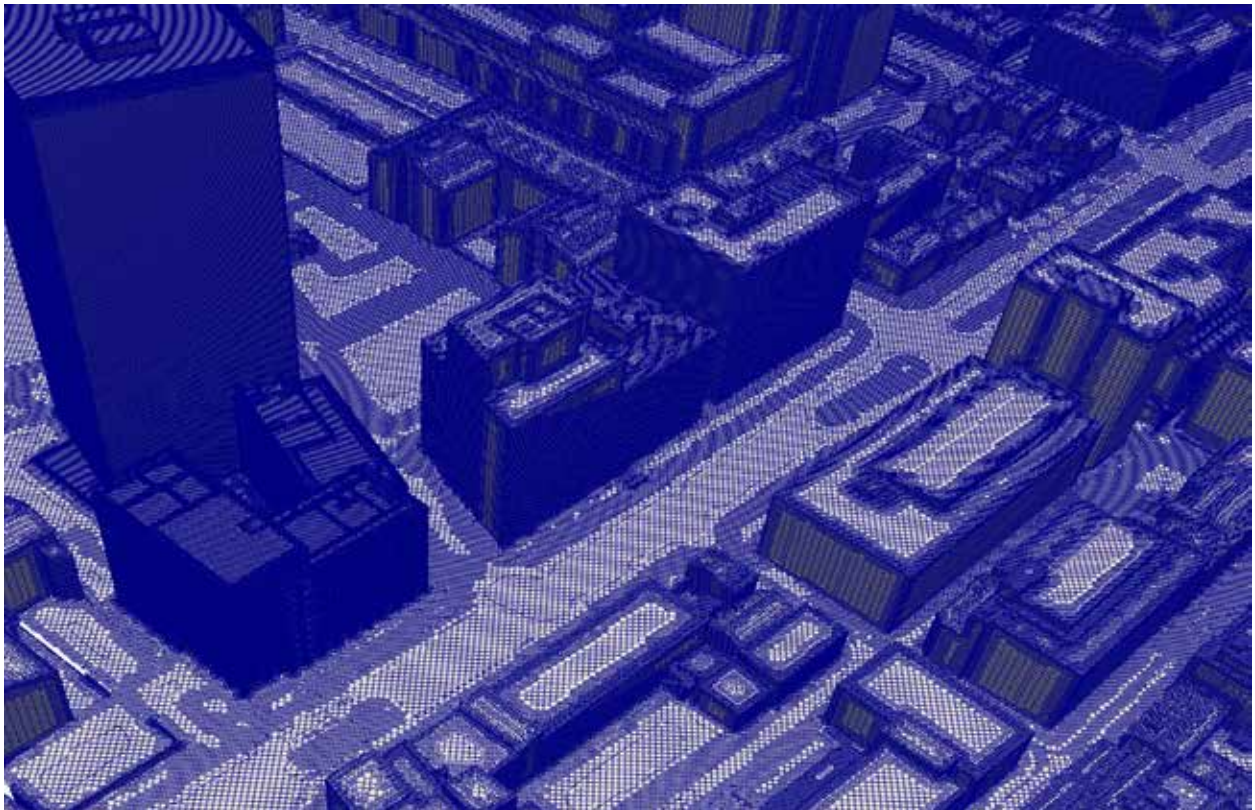


Fig. 12: Mesh Detail on Surrounds

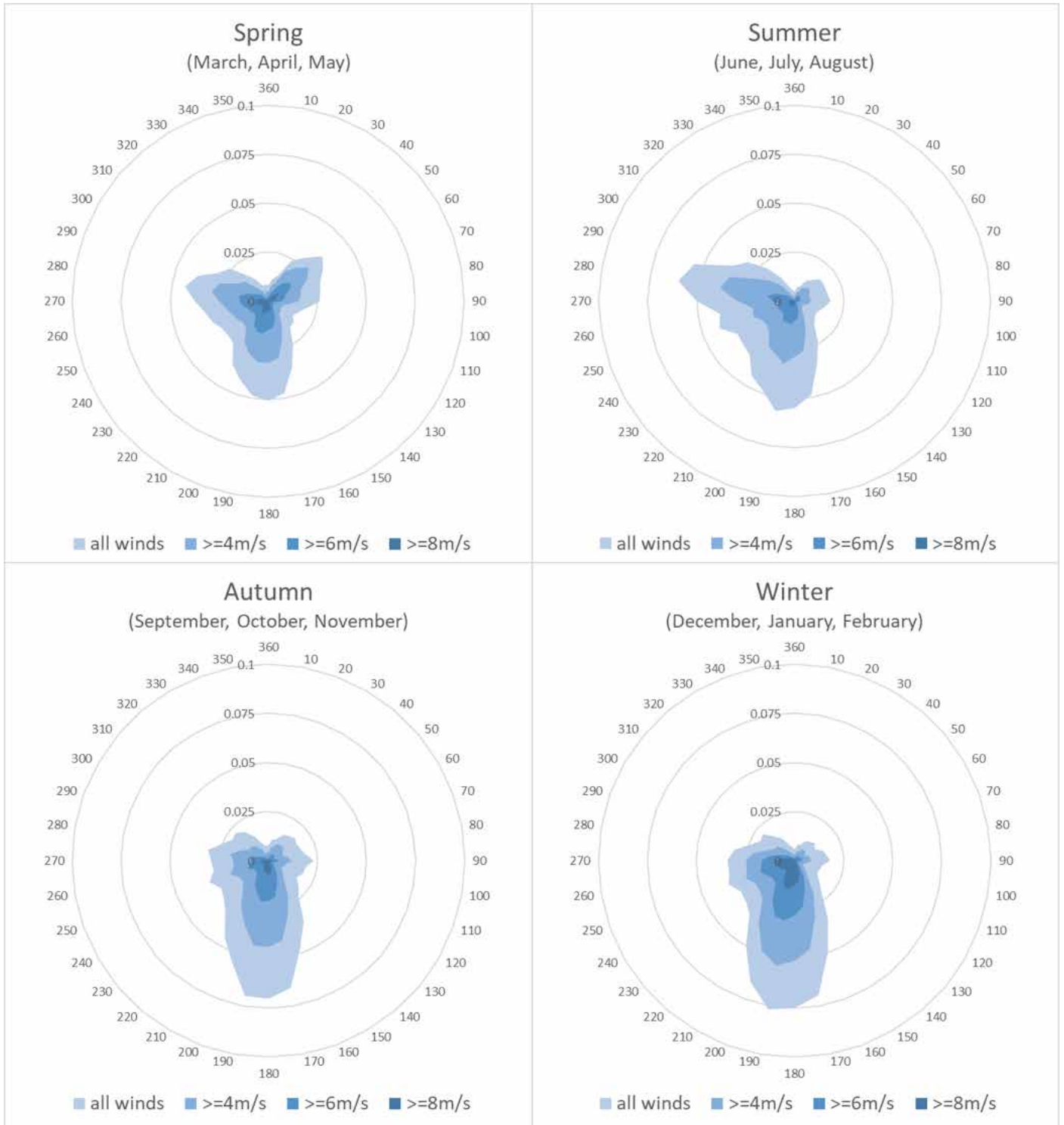


Fig. 13: Seasonal Wind Roses for Manchester International Airport (1990–2020)

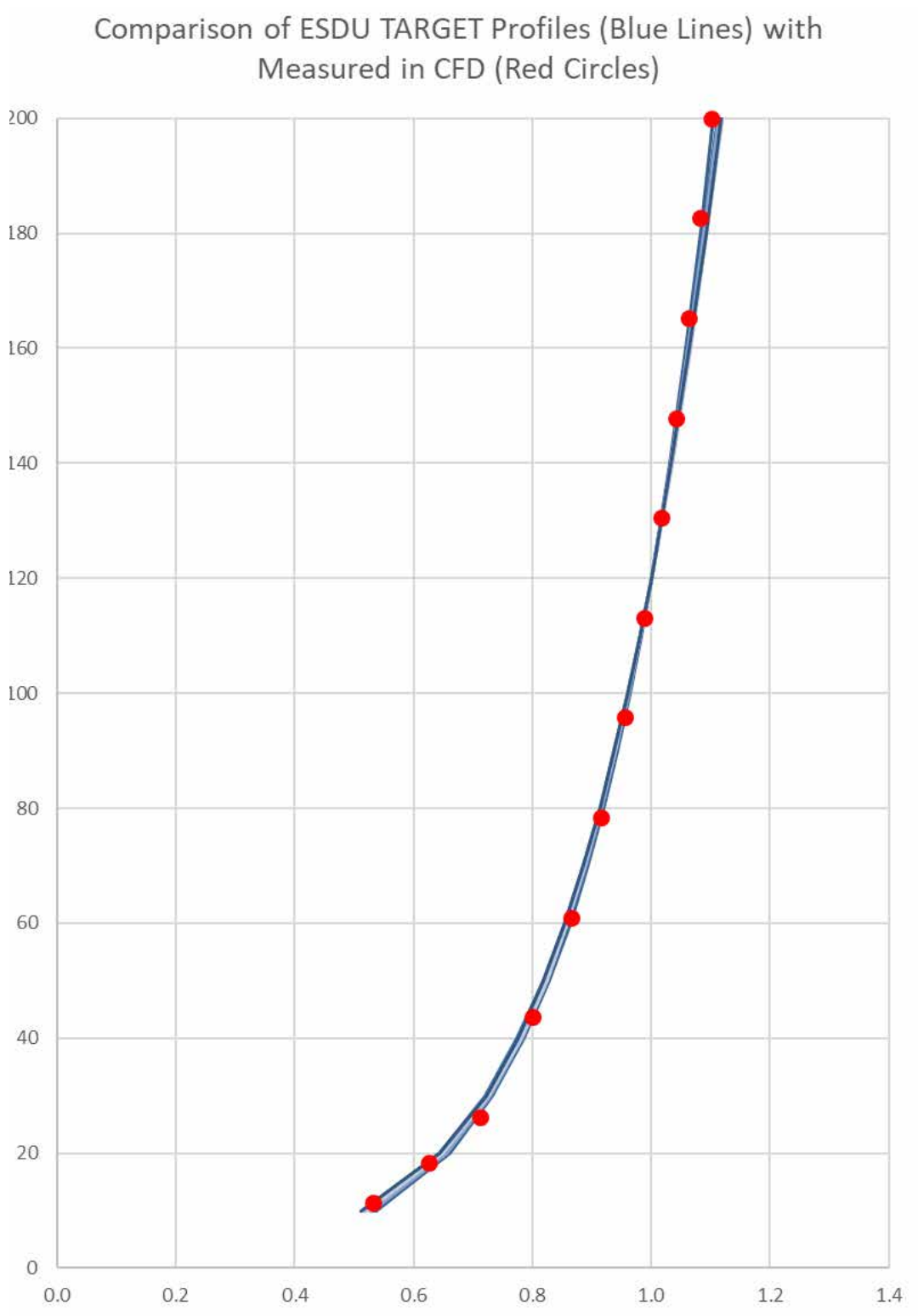


Fig. 14: Wind Profile for Port Street

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